

The Snakestone Experiments

An Early Modern Medical Debate

*By Martha Baldwin**

IN THE 1660s AND 1670s a heated dispute arose between two prominent natural philosophers, Athanasius Kircher and Francesco Redi, over the medicinal use of certain stones that merchants and missionaries had recently brought to Italy from various parts of India, China, and Southeast Asia (see Figure 1). Those who imported the stones, which reputedly were concreted naturally in the heads of indigenous poisonous cobra snakes, claimed that they acted as antidotes to all forms of poisoning in the human body. The high seriousness with which the debaters tested the claims of these merchants and missionaries, their painstaking gathering of experimental evidence, and the passion with which they constructed their arguments for and against the efficacy of this remedy suggest that the stones evoked issues far deeper than the prospect of adding another ingredient to the standard toxicological pharmacopoeia of Western Europe.

Indeed, the snakestone controversy addressed matters of vital interest to the European medical and scientific community, including questions about who had the authority to pronounce medical facts and to control medical knowledge and debates over the weight natural historians and physicians working in Europe should accord field experience and laboratory experience. Much of the controversy hinged on differing assumptions regarding the respective credibility of those reporting on natural phenomena observed in foreign lands and genteel Europeans observing experiments artificially contrived in Europe to test such reports. Historians of medicine and science have commonly invoked experiment as a fundamentally distinctive feature of the “new science” of the seventeenth century.¹ Yet

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¹ The manual and experimental nature of early modern science is traditionally contrasted with the speculative and theoretical nature of medieval science. For discussions of the meaning of *experiment* in the Scientific Revolution see Steven Shapin, “The House of Experiment in Seventeenth-Century England,” *Isis*, 1988, 79:373–404; and Peter Dear, “Jesuit Mathematical Science and the Reconstitution of Experience in the Early Seventeenth Century,” *Studies in the History and Philosophy of Science*, 1987, 18:133–175. John Heilbron has discussed how public demonstrations of experimental physics were increasingly incorporated in private lectures, scientific academies, and university classrooms; see John Heilbron, *Elements of Early Modern Physics* (Berkeley: Univ. California Press, 1982). Historians have long emphasized the link between experiments and scientific academies in the early modern period. Marie Boas Hall has examined experiments performed for the meetings of the Royal Society in *Promoting Experimental Learning: Experiment and the Royal Society, 1660–1727* (Cambridge: Cambridge Univ. Press, 1991). More directly related to the Florentine context is W. E. Knowles Middleton, *The Experimenters: A Study of the Accademia del Cimento* (Baltimore: Johns Hopkins Univ. Press, 1971). More recently Jay Tribby, in “Cooking (with) Clio and Cleo: Eloquence and Experiment in Seventeenth-Century Florence,” *Journal of the History of Ideas*, 1991, 52:417–439, has demonstrated that Redi’s experimental work owed much to the early modern rhetorical and literary tradition of conversing with the learned ancient natural philosophers.

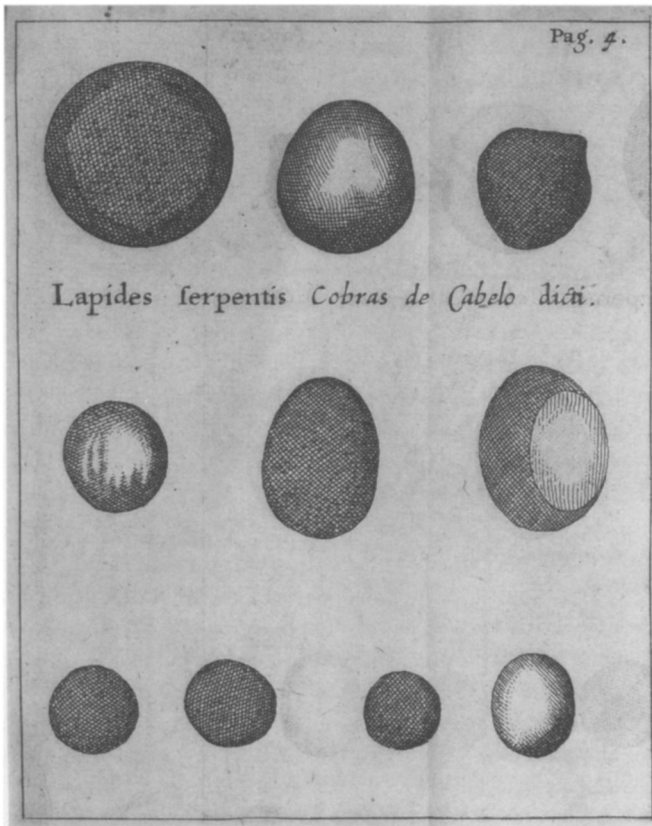


Figure 1. *Francesco Redi, Experimenta circa varias res naturales speciatim illas quae ex Indiis afferuntur (Amsterdam, 1685), p. 4. Redi offers his readers illustrations of several specimens of the so-called snakestone. This plate underscores Redi's insistence that he had used numerous specimens in his experimental tests of the reputed powers of the snakestones. The original edition of Redi's work was published in Italian in 1671. (By permission of the Houghton Library, Harvard University.)*

the evidence of experiment often remained moot to men engaged in discovering the truths of nature by such means. Since the learned men who argued over the snakestones' efficacy could not agree about the evidence provided by experimental trials, the controversy prompts historians to ask to what extent "experiments" proved anything in the seventeenth century. In sum, this debate—overlooked by historians of science and medicine, and perhaps appearing trivial to modern eyes—raises many issues that lurk behind the experimental science of early modern Europe. I suggest that it illustrates the tenuous and conflicting relations between experiment and theory in early modern medicine.

In their efforts to characterize early modern science, historians have recently emphasized its cultural and geographical specificity. Early modern experimental science in London was not the same as its counterpart in Caen or Leiden.² The snakestone debate also bears

² On the spatial and cultural varieties of early modern science see the essays in Roy Porter and Mikuláš Teich, eds., *The Scientific Revolution in National Context* (Cambridge: Cambridge Univ. Press, 1992). On the experimental work of a provincial scientific academy in France see David S. Lux, *Patronage and Royal Science in Seventeenth-Century France: The Académie de Physique in Caen* (Ithaca, N.Y.: Cornell Univ. Press, 1989). On

the stamp of a specific cultural and religious context, which this essay seeks to examine. Although physicians and natural philosophers in England, Germany, and France designed and conducted experimental trials to test the efficacy of the snakestone, the two major protagonists in the debate were firmly rooted in Italy. Athanasius Kircher (1602–1680), though German born, had lived in Rome for over three decades before he engaged in the snakestone controversy. As a member of the Society of Jesus, he had close ties to the papacy and to the Jesuit Aristotelian natural philosophers at the Collegio Romano. Kircher became the leading advocate for the efficacy of the new therapy (see cover illustration). His chief opponent, Francesco Redi (1626–1698), was a Tuscan and a loyal servant of the Medici court in Florence, where allegiance to Galileo and anti-Jesuit sentiment remained strong long after the 1633 condemnation of the *Dialogue Concerning the Two Chief World Systems*. Close beneath the surface of the debate lay the protagonists' keen rivalry for the patronage of the Medici in Florence, strong professional jealousies, competing economic interests in the production of pharmaceuticals, and discordant epistemologies.

ARRIVAL OF THE SNAKESTONES

As New World flora and fauna came to the attention of European physicians and as Europeans gave increasing attention to indigenous African and Asian medical therapies, seventeenth-century natural philosophers and physicians faced a vast expansion in the number of plant and animal substances purported to be of medicinal value. The snakestones, called *piedras della cobra de Capelos*, began to trickle into Europe, primarily from India, in the 1650s. The stones themselves, illustrated in Figure 1, were lenticular in shape, of green or reddish color, and about the size of a small Italian coin. By 1656 specimens of the stones had reached the Jesuit natural philosophers living at Rome and those affiliated with the Medici court in Florence.³ Jesuit missionaries returning to Rome for required consultation with officials in the Society's hierarchy first brought both reports and samples of the snakestones to Athanasius Kircher, a prolific natural philosopher of some renown who was curator of the Jesuit museum at the Collegio Romano.⁴ Likewise, foreign merchants and

Leiden see G. A. Lindeboom, "Dog and Frog: Physiological Experiments," in *Leiden University in the Seventeenth Century: An Exchange of Learning*, ed. Th. H. Lunsingh Scheurleer and G. H. M. Posthumus Meyjes (Leiden: Brill, 1975), pp. 279–293.

³ It is difficult to date precisely the first arrival of the snakestones in Europe, but we know that Michal Boym, a Polish Jesuit, returned to Rome from the Jesuit mission in China in 1652. During his three-year stay—at least part of which he spent at the Collegio Romano, where Kircher also resided—Boym labored to make China understood in the West. Soon after his return to China his book *Flora sinensis, fructus floresque* (Vienna, 1656), in which he described the powers of the snakestone and illustrated the serpent, appeared in print. Both Redi and Kircher knew of Boym's book; indeed, Kircher sent a copy to the grand duke of Florence. See Athanasius Kircher to Ferdinando II De Medici, 15 June 1656, in *Le opere dei discepoli di Galileo Galilei*, ed. Paolo Galluzzi and Maurizio Torrini, 2 vols. (Florence: Giunti-Barbèra, 1984), Vol. 2, p. 348. In 1658 Boym, in India, corresponded directly with the Tuscan grand duke; he referred to an earlier dispatch from Goa that included specimens of the snakestone. This letter is published in Giovanni Targioni-Tozzetti, *Notizie degli aggrandimenti delle scienze fisiche accaduti in Toscana nel corso di anni LX del secolo XVII*, 4 vols. (Florence, 1790; Bologna: Forni, 1967), Vol. 3, p. 244. On Boym's life see Robert Chabrie, *Michel Boym, Jésuite polonais et la fin des Ming en Chine* (Paris: Bossuet, 1933).

⁴ Athanasius Kircher was first professor, then scriptor, at the Collegio Romano. By the time of the snakestone debate he had established his reputation as an erudit man and had published works on magnetism, optics, and acoustics. Keenly interested in ancient civilizations, he had also spent years studying Egyptian hieroglyphs and Egyptian culture. He was known to many others for his interest in establishing a universal language and in the occult meanings of number. His later books concerned Noah's ark and the tower of Babel. Kircher's brief autobiography appeared posthumously as *Fasciculus epistolarum*, ed. H. A. Langenmantel (Augsberg, 1684). While a full cultural and intellectual biography of this fascinating late Renaissance figure remains to be written,

Dominican and Franciscan overseas missionaries brought specimens of these highly prized curiosities to the Tuscan court of Grand Duke Ferdinando II. In Florence the grand duke had the stones exhibited to several courtiers interested in natural philosophy who were associated with his Accademia del Cimento, including Francesco Redi.⁵

Interest in the remedy and in experiments to verify or refute its efficacy spread rapidly to natural philosophers in other European countries. Through other missionaries and merchants, specimens of the stones reached the fledgling Royal Society of London and botanists working in the Jardin du Roi in Paris. The eminent Robert Boyle conducted his own experiments, presumably at his private laboratory. In the early 1660s Jesuits brought specimens of the stones to the courts of the Holy Roman Emperor in Vienna and of Duke August of Brunswick-Lüneburg; experiments were undertaken in these cities as well. At least one Jesuit missionary took specimens of the snakestone to the court in China. Increasingly, accounts of the snakestone also circulated in contemporary travel literature.⁶

The arrival of these exotic stones in the late 1650s gave no hint of the scientific and medical controversy that would ensue. These were years when travelers, merchants, and missionaries were returning to Europe with all kinds of bizarre mineral, plant, and animal specimens that were used as medicaments in foreign cultures: sarsaparilla, armadillo bones, hair from the beards of tigers, chocolate, Mexican peppers, rhinoceros horns, and hippo-

recent scholarship has produced some helpful articles. See Maristella Casciato, Maria Grazia Ianniello, and Maria Vitale, eds., *Enciclopedia in Roma barocca: Athanasius Kircher e il Museo del Collegio Romano tra Wunderkammer e museo scientifico* (Venice: Marsilio, 1986); also useful is Valerio Rivesecchi, *Esotismo in Roma barocca: Studi sul Padre Kircher* (Rome: Bulzoni, 1982). Hans Kangro gives Kircher's scientific work even-handed treatment in *Dictionary of Scientific Biography*, 18 vols. (New York: Charles Scribner's Sons, 1970), Vol. 7, pp. 374–378. John Fletcher has contributed three important articles in another useful volume of essays, *Athanasius Kircher und seine Beziehungen zum gelehrten Europa seiner Zeit*, ed. Fletcher (Wiesbaden: Herzog August Bibliothek, 1988). I believe the most accurate depiction of Kircher is that in Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley: Univ. California Press, 1994). Older biographies include Conor Reilly, *Athanasius Kircher, S.J., Master of a Hundred Arts* (Rome: Edizioni del Mondo, 1974); and Joscelyn Godwin, *Athanasius Kircher: A Renaissance Man and the Quest for Lost Knowledge* (London: Thames & Hudson, 1979).

⁵ Targioni-Tozzetti, *Notizie* (cit. n. 3), gives many accounts of the frequent informal relations between the grand duke and the natural philosophers of his court; see Vol. 1, pp. 237–238, 306, 450–451, Vol. 2, p. 680, Vol. 3, p. 86. Courtiers such as Lorenzo Magalotti and Carlo Dati had direct access to Jesuit missionaries returning from China and the East Indies who called at the Medici court. On the Accademia del Cimento see Middleton, *Experimenters* (cit. n. 1); and Paolo Galluzzi, “L'Accademia del Cimento: ‘Gusti’ del principe, filosofia e ideologia dell'esperimento,” *Quaderni Storici*, 1981, 48:788–843.

⁶ For references to the snakestone in the early years of the Royal Society see *The Correspondence of Henry Oldenburg*, ed. and trans. A. Rupert Hall and Marie Boas Hall, 13 vols. (Madison: Univ. Wisconsin Press, 1965–1986), Vol. 4, p. 468, Vol. 5, pp. 446, 512. Oldenburg read a letter about the Roman experiments to the Royal Society on 15 Apr. 1668. It came from Philip Skippon, a protégé of John Ray and John Wilkins, and was entitled “Of the Nature of a Certain Stone, Found in the Indies, in the Head of a Serpent” (*Philosophical Transactions*, 1668, 1:102–103). On snakestones belonging to the Royal Society see Nehemiah Grew, *Musaeum Regalis Societatis; or, A Catalogue and Description of the Natural and Artificial Rarities Belonging to the Royal Society and Preserved at Gresham Colledge* (London, 1681), pp. 51–52. In France references to experiments on snakestones appeared in Pierre LeGallois, *Conversations de l'académie de Monsieur L'Abbé Bourdelot, contenant diverses recherches, observations, experiences, & raisonnemens de physique, medecine, chymie & mathématique* (Paris, 1672), pp. 69–73. LeGallois suggested that experimenters had tested the efficacy of the snakestones at the house of Moise Charas, a botanist at the Jardin du Roi and later a member of the Académie Royale des Sciences. John Fletcher, “Athanasius Kircher and Duke August of Brunswick-Lüneburg: A Chronicle of Friendship,” in *Athanasius Kircher*, ed. Fletcher (cit. n. 4), pp. 99–138, examines the manuscript correspondence between Kircher and August and is able to trace precisely how the snakestones arrived in the hands of the archduke—they were carried by the Jesuit Ferdinand Herberstein, sent by Kircher as a gift in December 1662 (pp. 112–113). On Jesuit presentation of the stones to the court of China see U. Libbrecht, “Introduction of the Lapis Serpentinus into China,” *Orientalis Lovaniensis Periodica*, 1987, 18:209–229. On reports of the snakestone in seventeenth-century travel literature see, e.g., Jean Baptiste Tavernier, *Six Voyages en Turquie, en Perse, et aux Indes*, 2 vols. (Amsterdam, 1678), Vol. 2, p. 392.

potamus teeth. Snakestones were simply one among the numerous exotic medicaments that virtuosi prized.

The returning missionaries and merchants also transmitted lore regarding the abilities of such natural products to cure various types of sickness. They reported that natives of India and China used snakestones to cure poisoning inflicted by snakebite. Supposedly, the stone adhered tenaciously when placed on top of a poisonous wound. After sucking up all the poison, it fell spontaneously from the wound, leaving the victim in perfect health. If later soaked in a bowl of milk, the snakestone was drained of its imbibed poison (which it imparted to the milk, turning it a greenish color) and could be used repeatedly.

KIRCHER'S EARLY TRIAL

Kircher's first account of the stones, in his *China illustrata* of 1667, ignited wide publicity about this wonder and its medical powers. Although Jesuit missionaries living in the East had assured him that the stones were part of native medical therapy, Kircher harbored no interest whatsoever in oriental medical theories; rather, he was interested in assembling field reports affirming the efficacy of the snakestones and in verifying these reports through a single experimental trial.⁷

Drawing primarily from interviews with the Polish Jesuit Michal Boym, who had spent years as a missionary in China (see Figure 2), Kircher reported in *China illustrata* that the local brahmins of the Quam-si Province of China skillfully captured native hooded cobra serpents and surgically extracted the stones from their skulls. The verbal and written reports of another Jesuit missionary, Henry Roth, specified that only the brahmins knew how to recognize the cobras that were naturally endowed with the marvelous stony concretion.⁸ Boym told Kircher that the brahmins also manufactured equally efficacious stones from a mixture of the heads, hearts, livers, and teeth of the serpents; although he noted that they guarded this recipe for the manufacture of artificial stones with strictest secrecy, he warned that some spurious stones were in circulation since the genuine merchandise commanded a high price.

Such evidence—from Jesuits who had lived in foreign cultures and who had witnessed the efficacy of the snakestones—led Kircher to attempt an experimental trial on the stone before endorsing it as a remedy for poisoning. Although he cited two specific case histories where Roth himself had used the stones with great success in India (once on his servant, bitten on the hand by a scorpion, and again on a man infected with a boil), Kircher claimed to have suspended judgment on the snakestone before performing his own experiment. His trial was carried out in Rome in 1663, “in front of amazed spectators,” on a dog that he had caused to be bitten by a viper. The Jesuit described his experimental result: “When this stone was placed on the dog’s snakebite, it stuck to the wound so that one could scarcely pull it away, and it remained fixed to the wound for a long time. Finally, having drained off all the poison, it fell away by itself, like a leech saturated with blood. The dog

⁷ Kircher's *China illustrata* first appeared at Amsterdam in 1667. The book circulated widely, appearing in a Dutch translation in 1668 and a French translation in 1670. I cite a recent English translation: Athanasius Kircher, *China illustrata*, trans. Charles Van Tuyl (Muskogee, Okla.: Indian Univ. Press, 1987), pp. 73–74, 197.

⁸ Henry Roth (also called Rodius), born in Bavaria in 1620, served as a member of the Jesuit mission in India, first on the island of Salsete near Bombay. Roth left for India in 1650 and governed the Jesuit college at Agra from 1659 to 1663. He went to Rome in 1663 to petition for more missionaries, then returned to Agra, where he died in 1667. Kircher cites his conversations with Roth in *China illustrata* and in *Magneticum naturae regnum sive disceptatio physiologia* (Rome, 1667). More information on Roth is available in Cornelius Wessels, *Early Jesuit Travellers in Central Asia, 1603–1721* (New Delhi: Asian Educational Services, 1992), pp. 199–200.

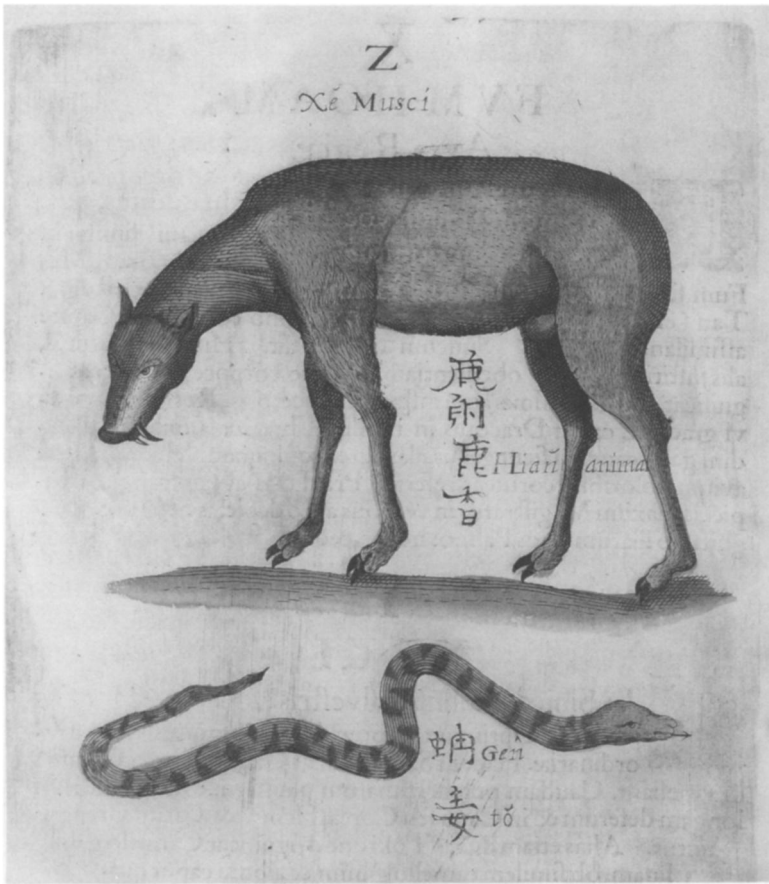


Figure 2. Michal Boym, S.J., *Flora sinensis, fructus floresque* (Vienna, 1656), unpaginated. Plate Z illustrates both the Chinese musk and the serpent, called by the Chinese “Gento,” from whose head the snakestone was reputedly extracted. (By permission of the Houghton Library, Harvard University.)

was free from the poison, and although feverish for a while, was restored to his former health after about a day.”⁹

Once his experiment on the dog had confirmed the field reports, Kircher became an advocate of snakestone therapy. Additional evidence of the stones’ efficacy came from another Roman, Carlo Magnini, who had performed an independent trial on a man bitten accidentally by a viper during the harvest season. Kircher recounted that his own verbal report of his dog experiment had inspired Magnini, “an indefatigable explorer of natural things,” to wish to replicate the experiment on a human; the “fortunate”—though not extraordinary—circumstance of a local peasant’s viper bite had granted Magnini the opportunity to put his own private stone to the test.¹⁰ Kircher reported that Magnini’s stone had behaved on the human just as his own had on the dog: after about two hours the

⁹ Kircher, *China illustrata*, trans. Van Tuyl (cit. n. 7), pp. 73, 80 (quotations). While experimenters focused on toxins injected into the body by animal, insect, and snake bites, many, including Kircher, assumed that the snakestones could be applicable to far wider types of what they held to be “poisonous” diseases.

¹⁰ Kircher, *Magneticum naturae* (cit. n. 8), p. 52. Here and elsewhere, translations are mine unless otherwise indicated.

saturated stone had fallen from the wound, and the patient had revived slowly, as if coming out of a deep sleep. After being given some cardiac drugs the laborer had returned to perfect health.

Kircher further publicized the snakestone in another book, *Magneticum naturae regnum sive disceptatio physiologia* (Rome, 1667), published in the same year. Here Kircher gave a far fuller, though essentially similar, account of the stones and their operation on victims of poisoning. He also presented more specific information on his own experiment. In 1663 a crate of vipers arrived at the Jesuit pharmacy in Rome, where they were customarily used as a chief ingredient in the manufacture of theriac, a prestigious pharmaceutical widely prescribed in early modern medicine for snakebites and for a variety of diseases. Recognizing an opportunity to test the snakestone remedy, Kircher assembled a "multitude of Fathers and other curious men" to observe his experiment and caused the dog to be bitten.¹¹

While Kircher had given only a fleeting explanation of the remedy's efficacy in his work on China, he had written *Magneticum naturae* specifically to publicize his theory on the operation of occult magnetic forces throughout the universe. Here he placed the snakestones within an elaborately systematized doctrine of toxicology. Deeply influenced by Hermetic cosmological ideas and Helmontian ideas of disease, Kircher used the familiar notion of the attraction of like substances to explain the power of the snakestone, a natural product of a toxic serpent, to attract magnetically and sympathetically toxic spirits circulating in the bloodstream. In an earlier book, the *Mundus subterraneus* (1665), Kircher had constructed his own theory of the natural action of poisons. Drawing from the Paracelsian doctrine of cure by similar substances, he posited that all poisonous animals, minerals, and plants sought to attach themselves to other poisons, just as iron sought to attach itself to a lodestone. He further held that all poisons had natural antidotes that natural philosophers could discover and cause to act magnetically upon toxins. It was Kircher's hope that physicians and natural philosophers could utilize his magnetic philosophy as a theoretical foundation for discovering many more antidotes to poisons that attack the human body.¹²

REDI'S RESPONSE

Kircher did not have the last word on the matter, which piqued the interest of the distinguished Tuscan court physician and natural philosopher Francesco Redi. Indeed, Redi was

¹¹ *Ibid.*, pp. 50–58. Theriac—like mithridatum—was an elaborate compound of vipers and botanicals. One of the most prestigious medicaments of the seventeenth century, it was frequently prescribed not only as an antivenom for snakebite but also for dropsy, epilepsy, melancholy, and plague; many physicians believed it to possess remarkable curative and prophylactic powers. Recipes for the manufacture of theriac abound in early modern medical and pharmaceutical texts. See Gilbert Watson, *Theriac and Mithridatium: A Study in Therapeutics* (London: Wellcome Historical Medical Library, 1966); Giuseppe Olmi, "Farmacopea antica e medicina moderna: La disputa sulla teriaca nel cinquecento bolognese," *Physis*, 1977, 19:197–246; and Richard Palmer, "Pharmacy in the Republic of Venice in the Sixteenth Century," in *The Medical Renaissance of the Sixteenth Century*, ed. A. Wear, R. K. French, and I. M. Lonie (Cambridge: Cambridge Univ. Press, 1985), pp. 100–117, esp. pp. 108–110.

¹² Kircher, *Magneticum naturae*, pp. 50–58. Kircher had given an earlier explication of his toxicological theories in *Mundus subterraneus*, 2 vols. (Amsterdam, 1665), Vol. 2, pp. 104–161. Homeopathic principles explained why poisonous creatures provided particularly potent antivenoms. Poisons and antivenoms were especially plentiful in the torrid zone, where creatures like snakes were born spontaneously in the fermenting slime of flooded riverbanks. To Kircher, the presence of poisons on earth demonstrated the benevolence of God in creating the universe, since poisonous animals, minerals, and plants served to purify the air and earth and to render the land and atmosphere fit for human habitation.

so aroused by Kircher's claims that when he published the results of his own experimental investigations on snakestones, in 1671, he deliberately addressed them to Kircher, calling attention to the Jesuit's experimental inadequacies by the clever but not uncommon strategy of presenting his rebuttal as a lengthy letter to his opponent. Redi's 1664 work on venomous serpents had created much notice at home and abroad. By 1666 his reputation as a practicing physician was such that he had won appointment as court physician and superintendent of the ducal pharmacy. In his challenge to Kircher, *Esperienze intorno a diverse cose naturali e particolarmente a quelle che ci son portate dall'Indie fatte da Francesco Redi e scritte in una lettera al Reverendissimo Padre Atanasio Chircher della Compagnia de Giesù*, Redi did not confine himself to the matter of the snakestones. He used this published letter to discuss and debunk a broad array of remedies imported from exotic sources—ginseng for longevity, elephant bristles for dizziness, birds' nests for gout, pulverized armadillo shells for deafness. But Redi accorded the snakestone the prominent place in his discourse. Indeed, the snakestone matter occupied the opening pages of the letter and accounted for the greatest part of the experimental proof he offered in his broad refutation of novel and exotic remedies (see Figure 3).¹³

Although he thanked Kircher obsequiously for the news of the two experiments performed at Rome, Redi stated plainly that the Jesuit was neither the first nor the only man to test the remedy by experiment. He too had directed "many experiments at different times" on the snakestones. Using stones that three Franciscan monks, called *Zoccolanti*, had brought among other gifts of natural curiosities to Grand Duke Ferdinando II in the winter of 1662, Redi had come to his own conclusions.¹⁴ According to Redi's letter, the snakestones had immediately stimulated great interest at the court, and the Franciscans had been eager to prove their power to counteract the toxin of the deadly viper. However, cold weather had foiled the hopes of the experimenters, for even the court's most highly skilled viper catcher had been unable to capture any specimens. Accordingly, Redi was obliged to conduct his first experiments with another known toxin, oil of tobacco.

Redi duly assembled a crowd of men to attest to his trials. He claimed to have tried his snakestones in front of "numerous philosophers and physicians of the University of Pisa, the most learned and most esteemed men," who assembled to judge for themselves the Franciscans' marvelous claims. Redi recounted his experimental procedure in far greater detail than Kircher. In his earliest trials Redi soaked white thread in the toxic oil, threaded

¹³ Redi addressed the snakestone in *Esperienze intorno a diverse cose naturali e particolarmente a quelle che ci son portate dall'Indie fatte da Francesco Redi e scritte in una lettera al Reverendissimo Padre Atanasio Chircher della Compagnia de Giesù* (Florence, 1671), pp. 1–13, 59–62. Redi would be canonized in eighteenth-century Italian literature celebrating the glories of Florentine science. Despite this hagiographic tendency, a useful account of his life is found in Angelo Fabroni, *Vitae Italorum doctrina excellentium qui saeculus xvii e xviii floruerunt*, 20 vols. (Pisa, 1779), Vol. 3, pp. 178–325. A more recent work is Maria Luisa Altieri Biagi, *Lingua e cultura di F. Redi, medico* (Florence: Olschki, 1968). Luigi Belloni provides a good biographical account of Redi in his entry in the *DSB*, Vol. 11, pp. 341–343. See also Peter Knoefel, *Francesco Redi on Vipers* (Leiden: Brill, 1988); Bruno Basile, *L'invenzione del vero: Studi sulla letteratura scientifica da Galileo ad Algarotti* (Rome: Salerno, 1987), esp. pp. 49–88; Tribby, "Cooking (with) Clio and Cleo" (cit. n. 1); and Paula Findlen, "Controlling the Experiment: Rhetoric, Court Patronage, and the Experimental Method of Francesco Redi," *History of Science*, 1993, 31:35–64.

¹⁴ On the presentation of natural curiosities by missionaries, merchants, and natural philosophers attempting to earn the favor and goodwill of reigning monarchs and nobles see Paula Findlen, "The Economy of Scientific Exchange in Early Modern Italy," in *Patronage and Institutions: Science, Technology, and Medicine at the European Court, 1500–1750*, ed. Bruce T. Moran (Rochester, N.Y.: Boydell & Brewster, 1991), pp. 5–24. For the cultural context of princely collections of curiosities and natural marvels see Adalgisa Lugli, *Naturalia et mirabilia: Il collezionismo enciclopedico nelle Wunderkammern d'Europa* (Milan: Gabriele Mazzotta, 1983); and Krzysztof Pomian, *Collectors and Curiosities: Paris and Venice, 1500–1800*, trans. Elizabeth Wiles-Portier (Cambridge: Polity, 1991).



Figure 3. *Francesco Redi, Experimenta circa varias res naturales speciatim illas quae ex Indiis afferuntur (Amsterdam, 1685), frontispiece. The prominence of the exotic snake in the foreground suggests how important the snakestone was in Redi's book. Note the swarthy native offering the classical muse a gift of the stone. The original edition of Redi's work, published in Italian in 1671, had no frontispiece illustration. (By permission of the Houghton Library, Harvard University.)*

a set of needles, stabbed three roosters deep in the thigh with a needle, and pulled the toxic thread through the flesh. He immediately applied the snakestone to the thigh, directly on top of the bloody wound, and awaited the outcome. Redi reported that in all three trials the snakestone had vigorously glued itself to the wound, just as Kircher said had happened in his earlier trial and just as the Franciscans claimed had happened in India.¹⁵ However, the outcome had not matched anyone's expectations: the first two cocks had quickly died; the third cock, however, had not responded to being poisoned, despite being stabbed twice more and having the oil of tobacco rubbed directly into the freshly bleeding wound. Subsequently Redi had resorted to using a larger probe on its left thigh and to inserting a fresh supply of the toxin. Finally, the cock succumbed visibly to the poison and Redi reapplied

¹⁵ Redi, *Esperienze* (cit. n. 13), p. 7: "conforme che era stato predetto, vi si applicò tenacemente."

the snakestone. To Redi's consternation and to the joy of the believing *Zoccolanti*, the cock had fully recovered by morning.

Redi confessed that this publicly performed set of trials had produced no consensus among the witnesses. While Redi had been unable to explain the survival of the third cock, the *Zoccolanti* and their partisans were equally baffled by the deaths of the first two. Redi was forced to concede, "I have up to here proved nothing or little about the fabulous gifts of the stones with only the experiments using the oil of tobacco."¹⁶

Had Redi stopped here with his experiments, in all probability no debate would have followed; the evidence would have been inconclusive and Redi may well never have gone on to challenge publicly the vast assortment of medicines from the Indies. But while Kircher had been content with his single trial to verify the potency of the snakestones, Redi had different experimental standards. He insisted on repeating the trials and changing the toxins and animal species subjected to his tests. Indeed, the early failure of one trial to conform to his other experimental evidence may well have stimulated Redi's persistence.

What inspired Redi to persist in his early snakestone experiments? While he is silent on the matter, historians may speculate. Redi participated in at least some of the meetings of the Accademia del Cimento, where medicinal matters were of interest and where members commonly observed and discussed experimental procedures and experimental apparatus. Such meetings may well have influenced him. Furthermore, Redi's position as superintendent of the ducal foundry and pharmacy allowed him almost unlimited access to traditional pharmaceutical ingredients for his experimental trials, including toxic substances such as vipers and tobacco oil. Moreover, Redi was producing two important works on vipers and viper venom during the very years when he was testing the snakestones, so toxicological matters were very much on his mind. The first, *Osservazioni intorno alle vipere*, appeared in 1664, roughly a year after his earliest trials of the snakestones; the second, *Lettera sopra alcune opposizioni fatti alle sue Osservazioni intorno alle vipere*, appeared in 1670, the year before he published in full the results of his snakestone trials in his letter to Kircher.¹⁷

Evidence in *Esperienze* indicates that Redi continued to perform intermittent experiments on snakestones over a nine-year period. He started the first set in the winter of 1662 and concluded the last set shortly before the appearance of his published challenge to Kircher in 1671. Redi detailed five additional groups of experiments performed after the initial set in 1662; this stands in stark contrast to Kircher's single trial, performed in 1663. Redi's subsequent experiments served to convince him of the indubitable worthlessness

¹⁶ *Ibid.*, p. 11.

¹⁷ These books, *Osservazioni intorno alle vipere* (Florence, 1664) and *Lettera sopra alcune opposizioni fatti alle sue Osservazioni intorno alle vipere scritta alli Ab. Bourdelot, Sig. di Conde e. S. Leger e Alessandro Moro* (Florence, 1670), have been made accessible to modern readers in Peter Knoefel's translation; see Knoefel, *Redi on Vipers* (cit. n. 13), pp. 1–50. The nature of Redi's relationship to the Accademia del Cimento is somewhat puzzling. While Redi called himself a member, his name does not appear on the list in Lorenzo Magalotti's *Saggi di naturali esperienze* (Florence, 1667), the anonymously published volume recording the experiments of the Florentine Accademia del Cimento as a corporate body. See Middleton, *Experimenters* (cit. n. 1), pp. 22–39; and Ugo Baldini, "La scuola galileiana," in *Storia d'Italia*, Vol. 3, ed. Gianni Micheli (Turin: UTET, 1980), pp. 381–463, on pp. 408 n. 10, 415 n. 26. It is unclear precisely what Redi's duties at the ducal pharmacy involved. In all probability he did not personally concoct herially based medicaments. But even though the appointment may have been largely honorary, Redi was responsible for verifying the purity of pharmaceuticals. On the ducal pharmacy see R. Grassini, "La chimica e la farmacia in Firenze sotto il governo mediceo," *Rivista di Fisica, Matematica e Scienze Naturali*, 1907, 8:325–345. Targioni-Tozzetti reproduces the mid-seventeenth-century regulations governing the pharmacy in the Florentine hospital of S. Maria Nuova in his *Notizie* (cit. n. 3), Vol. 3, pp. 400–402. Tribby, "Cooking (with) Clio and Cleo" (cit. n. 1), and Findlen "Controlling the Experiment" (cit. n. 13), also discuss Redi's position as the ducal pharmacist.

of the snakestones, for in these later experiments every poisoned animal treated with a snakestone died. In addition to introducing viper venom as a toxin, Redi also had experimented with poisonous scorpions imported from Tunisia. Likewise, he had varied the species of fowl subjected to his experimental torments—rock pigeons, barnyard chickens, and guinea hens all succumbed despite the application of the marvelous antidote. He even went so far as to change the stones he used, substituting one borrowed from Giovambatista Cheluzzi, a well-respected local physician and professor of medicine who had procured a fresh supply of snakestones from a Dominican missionary returning from the Indies.

After assembling all the evidence of his experimental trials, Redi confidently asserted that he had proof of the worthlessness of the stones as an antivenom. His only remaining task was to explain the conflicting evidence of the two experiments at Rome and of the exceptional outcome in his own 1662 trials. Emphasizing that he had come to his conclusion “after many attempts and repetitions,” made with diligence, Redi simply ascribed the three anomalous cases to “chance” or “freak of nature.”¹⁸ In sum, his trials had been exhaustive; Kircher’s, by clear implication, had not.

When Redi pointed to the repetition of his own experiments as a sign of greater certainty, he was not appealing to a new concept. The very motto of the Florentine scientific academy, “Provando et riprovando” (“By testing and retesting”), suggested the importance that he and his fellow Tuscan experimenters attached to repeatability as a criterion for establishing truths derived from experiments. Nor was this criterion a Tuscan invention; English and French writers earlier in his century had appealed to replication and repeatability as hallmarks of experimental certainty. Recent work on the early experimental activity of the Royal Society of London has shown that mid-seventeenth-century English experimenters hailed the repetition of experiments as an important criterion for the establishment of a scientific fact. But Redi’s persistence was unusual for his day. His contemporaries were astonished at his willingness to put 20,000 oakgalls and 250 vipers to the test in unrelated trials.¹⁹

KIRCHER DEFENDED

Although Redi considered his higher standards of evidence to be beyond reproach, and although Kircher never directly answered the challenge launched against him, Redi’s letter did not close the dispute. Six years later, Kircher’s student and assistant Giuseppe Petrucci rose to defend his master by penning a direct response, *Prodromo apologetico alli studi Chircheriani*. Having Petrucci respond had several advantages. First, it distanced the aging Kircher from the passion of the debate. Moreover, since Petrucci was not a Jesuit, he had greater liberty to directly and brazenly challenge the Tuscan physician; his lay status exempted him from the clumsy censorship processes internal to the Jesuit order. He could also meet Redi on his own linguistic ground, writing in vernacular Italian rather than the lofty Latin of the Jesuit schools. Petrucci, a lawyer, made it clear to his readers that he considered his master to have been slandered. He viewed his own book as a defense “contro maligne accuse portate da’scrittori di pochissima stima”; he faulted Kircher’s critics for their “invidiosa e stridente ignoranza,” and he berated the biting accusation of his “maligni detrattori.” Without naming Redi as the enemy, Petrucci could defer to the esteemed

¹⁸ Redi, *Esperienze* (cit. n. 13), pp. 11, 13.

¹⁹ See Shapin, “House of Experiment” (cit. n. 1); and Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, N.J.: Princeton Univ. Press, 1985). On Redi’s numerous trials see Findlen, *Possessing Nature* (cit. n. 4), p. 217.

Tuscan as a “diligentissimo investigator della natura” and in the same breath, albeit anonymously, damn “those who if they don’t care to believe in something, will not fail to find motives for believing in whatever they are already convinced.” That Kircher had at least some role in the production of the book is suggested by its dedication to one of Kircher’s staunchest patrons and by its publication in Amsterdam at the press that handled all of Kircher’s works.²⁰

Petrucchi’s defense of his master consisted of a three-pronged refutation of Redi. First, he demonstrated that Kircher had now accumulated far more evidence of the snakestone’s power than had appeared in his books, which by now were ten years old. Petrucci cited reports and letters sent to Kircher by Italian nobles and clerics who had personally witnessed the snakestone’s operation in various cases of accidental poisoning.²¹ Petrucci also claimed that Redi’s experiments had failed because the Florentine snakestones were fraudulent and impotent imitations. Finally, he portrayed Redi as an outdated conservative who stubbornly refused to admit any new experimental evidence that challenged his fixed and preconceived ideas of efficacious medical remedies.

While Petrucci viewed Kircher and Redi as the principal antagonists on the matter, he noted that their debate was of interest to a far wider group of physicians and natural philosophers. He cited the mounting evidence of experiments performed outside Rome and Florence. The *Giornale de Letterati* had published in 1668 a narration of seventeen successful experiments performed with snakestones, principally on dogs, at the express command of the Holy Roman Emperor Leopold in Vienna. The same journal had related a number of similarly supportive experiments performed by the well-known professor of chemistry Otto Tachenius in Venice in the same year.²²

²⁰ Giuseppe Petrucci, *Prodomo apologetico alli studi Chircheriani, nella quale con un’apparato di saggi diversi, si da prova dell’esquisito studio ha tenuto il celebratissimo padre, Atanasio Chircher, circa il credere all’opinioni degli scrittori, si de’ tempi andati, come de’ presenti, e particolarmente intorno a quelle cose naturali dell’India, che gli furon portate, ò referte da quei che abitarono quelle parti* (Amsterdam, 1677). Petrucci is particularly defensive of Kircher’s reputation in his letter of dedication. See also pp. 6, 11, 24, 26. The book was dedicated to Johann Friedrich Waldstein, bishop of Prague and primate of Bohemia. It was published by the Amsterdam printer Janssonius, who published many of Kircher’s volumes, including *Mundus subterraneus* (1665), *China illustrata* (1667), *Ars magna sciendi* (1669), *Latium* (1671), *Arca Noe* (1675), and *Turris Babel* (1679). The illustration of the cobra serpent in Petrucci (p. 9) is identical with that in the 1667 edition of Kircher’s *China illustrata* (cit. n. 7), p. 81.

²¹ Petrucci, *Prodomo apologetico alli studi Chircheriani*, addressed the snakestones on pp. 3–26, 45–46, and 62–66. Most but not all of those whom he cited as submitting evidence were members of the Society of Jesus. Moreover, Petrucci noted, subsequent to his 1667 defense of the stones Kircher had personally observed more instances of their efficacy on human subjects. While vacationing in Tivoli, Kircher had applied the stone with great success to Giovanni Andrea Savini, a famous Jesuit preacher who had been bitten at night by a poisonous insect or spider; when making spiritual exercises in Monte S. Eustachio, Kircher had had the unexpected opportunity to put the stone to the test when a local noble brought him a dog bitten by a viper; even in the course of ordinary life at the Collegio Romano, Kircher had tested and witnessed the efficacy of the snakestone on the infected arm of his own amanuensis.

²² On the *Giornale* see Jean-Michel Gardair, *Le “Giornale de’Letterati” de Rome (1668–1681)* (Florence: Olschki, 1984). References to the snakestones are found in the journal’s reviews of Kircher’s and Redi’s work (1668, 1:75; 1672, 3:72). A French translation of the Viennese experiments appeared in *Collection académique, Recueil de memoires, ou Collections de pièces académiques concernant la médecine, l’anatomie & la chirurgie, la chymie, la physique expérimentale, tirées de meilleures sources*, 16 vols. (Paris/Dijon, 1754–1787), Vol. 4 (1757), p. 138. Otto Tachenius further endorsed the snakestone as a remedy for the particular acid of snake venom in his later works; see the English translation entitled *Otto Tachenius, His Clavis to the Ancient Hippocratical Physick or Medicine*, trans. J. W. (London, 1677), p. 109. Here Tachenius fit the remedy into his broader medical theory about the ability of various acidic substances (such as that of the snakestone) to attract other “specifick morbus acids” causing sickness in the human body.

COMPETING SOCIAL AND PROFESSIONAL INTERESTS IN THE SNAKESTONE DEBATE

Thus the experimental trials provoked a serious debate about the stones' efficacy. The experiments not only failed to adjudicate the controversy, but indeed seemed to protract it. I believe that much of the animus of the dispute lay in the debaters' disagreement over who could legitimately determine medical knowledge. Redi had good reason for his claim to speak authoritatively on medical matters. He was, after all, a university-trained physician; he had graduated from the University of Pisa in 1647 and was registered at the Collegio Medico in Florence the following year. In choosing his profession as a physician, he had followed in the footsteps of his father, Gregorio Redi, a Florentine physician with ties to the Medici court. Recent work by Jay Tribby and Paula Findlen has depicted Redi as the courtier physician par excellence and has examined his extensive activity as a naturalist, experimenter, poet, philologist, and literary academician. Findlen has demonstrated, with great sophistication, that it was Redi's stature at the court that enabled him to pursue his experimental activities; I would alter this interpretation by adding that it was Redi's stature *as a physician* that earned him his entrée to court circles. The grand duke rewarded Redi for his services *qua* physician by appointing him superintendent of the ducal pharmacy, the source of critical ingredients for his laboratory trials. By the end of his life Redi had become so successful that he was prescribing regimens and medical therapies for an impressive array of foreign clients, many of whom he had never seen. The poet Jean Chapelain wrote from Paris asking Redi's professional advice as a physician for Valentin Conrart, perpetual secretary of the Académie Française and a longtime sufferer of gout.²³ Even a superficial review of the three volumes of Redi's posthumously published correspondence reveals that the bulk of his epistolary efforts centered on medical advice rather than lofty investigations of natural philosophy.

Recent work by other scholars of the seventeenth century has shown that not only in Italy were learned physicians like Redi defending what had traditionally been designated their exclusive territory. Harold Cook has shown that English physicians, especially those belonging to the Royal College of Physicians, were zealously guarding the doors to medical knowledge and were deeply suspicious of the claims of empirics, midwives, surgeons, and pharmacists to speak authoritatively on medical matters. Historians of seventeenth-century French medicine have also demonstrated the increased efforts by learned practitioners to protect their professional boundaries from the incursions of competitors.²⁴

The different cultural contexts in which Kircher and Redi lived suggest yet further issues driving the snakestone debate. Redi operated as a courtier physician who earned his livelihood attending the sicknesses of the Tuscan aristocrats. He had tight ties to the Medici court, but he by no means exercised a monopoly in treating the ducal family and the Florentine nobles. Indeed, he was constantly competing with other court physicians for

²³ See Valentin Conrart, *Lettres à Lorenzo Magalotti*, ed. Gabriel Berquet and Jean Pierre Collinet (Saint-Étienne: Univ. Saint-Étienne, 1981), pp. 63, 71, 73.

²⁴ See Harold Cook, *The Decline of the Old Medical Regime in Stuart London* (Ithaca, N.Y.: Cornell Univ. Press, 1986); Cook, "Good Advice and Little Medicine," *Journal of British Studies*, 1994, 33:1–31; Cook, "The New Philosophy and Medicine in Seventeenth-Century England," in *Reappraisals of the Scientific Revolution*, ed. David C. Lindberg and Robert S. Westman (Cambridge: Cambridge Univ. Press, 1990), pp. 397–436; L. W. B. Brockliss, *French Higher Education in the Seventeenth and Eighteenth Centuries* (Oxford: Oxford Univ. Press, 1987); and Françoise Lehoux, *Le cadre de vie des médecins parisiens aux XVIe et XVIIe siècle* (Paris: Picard, 1976). On the medical profession in the Florentine context see Carlo Cipolla, *Miasmas and Disease: Public Health and the Environment in the Pre-Industrial Age*, trans. Elizabeth Potter (New Haven, Conn.: Yale Univ. Press, 1992).

the attention, esteem, and business of his noble clientele. Since attacking his competitors directly could transgress the courtiers' delicate code of genteel behavior, he chose instead to enhance his stature as a physician by participating in scientific disputes with men living *outside* the confines of Tuscany. In 1670 he had attacked Moise Charas, a distinguished French physician, chemist, and authority on poisons and vipers, in much the way he now attacked Kircher. He would later quarrel openly with Filippo Bonnani, another Roman Jesuit, about the doctrine of spontaneous generation of insects.²⁵ It was no accident that each of these antagonists lived far beyond the Tuscan realm and posed no immediate threat to his courtly standing in Florence.

In his public refutation of Kircher, Redi may also have been playing to a growing Florentine tradition of disdain for the Jesuits. As Galileo became more and more enshrined as a Tuscan hero, and as Jesuit natural philosophers came increasingly to be viewed as dreary inculcators of an outdated Aristotelian natural philosophy, Redi's audiences may well have delighted in seeing Kircher, the Jesuit showpiece of erudition, refuted, if not openly derided. Redi's private correspondence with Neapolitan natural philosophers reveals that at least some of his contemporaries viewed him—not entirely correctly—as a fervent opponent of the Jesuits.²⁶

Redi also cleverly used his scientific disputations to promote the image of the Medici as valiant and generous patrons of scientific investigation, further endearing himself to Cosimo III, upon whom his medical practice was so dependent. Indeed, in his account of the snakestone experiments conducted in Tuscany, Redi missed no opportunity to drive home the point that he had the honor of serving in a court where learned men loved to congregate, where the grand dukes had long maintained a fine pharmacy and botanical garden, and where Cosimo kept a full menagerie of exotic animals useful for medical experiments.²⁷

The Medici grand dukes had for generations prided themselves on maintaining botanical gardens and pharmacies where their hired pharmacists produced the best medicaments in the duchy. Although his position as director of the ducal pharmacy may have been largely honorary, Redi did have the authority—and responsibility—to verify the purity and authenticity of all pharmaceutical substances produced there. Thus his official position in the Tuscan court enhanced his authority to pronounce the truth in the matter of the snakestones. Moreover, theriac, the traditional antidote to snake venom, was, within the confines of the Tuscan state, a monopoly of the ducal pharmacy; physicians and patients and pharmacists

²⁵ For a depiction of the highly competitive atmosphere in which Redi plied his trade see Targioni-Tozzetti, *Notizie* (cit. n. 3), Vol. 3, p. 173. The attack on Charas formed the basis of Redi, *Lettera sopra alcune opposizioni* (cit. n. 17); Redi attacked Bonnani in *Osservazioni intorno agli animali viventi che si trovano negli animali viventi* (Florence, 1684).

²⁶ On Tuscan attitudes toward the Society of Jesus see Eric Cochrane, *Florence in the Forgotten Centuries, 1527–1800* (Chicago: Univ. Chicago Press, 1973), esp. pp. 211–212, 253, 386. On the Neapolitan perception of Redi as an opponent of the Jesuits see Antonio Borrelli, “Fortuna di Francesco Redi a Napoli nel sei-settecento,” *Acta Neapolitana*, 1987, 7:399–427. In fact Redi was on fairly friendly terms with Florentine Jesuits and was always polite to them in his published works. His correspondence reveals that he frequently gave medical advice to and exchanged books with individual Jesuits in Italy; see *Lettere di Francesco Redi*, ed. G. Cambiagi, 3 vols., 2nd ed. (Florence, 1779–1795), Vol. 3, pp. 116, 124–125, 144.

²⁷ For a full portrayal of Redi's place in the Medici court see Findlen, *Possessing Nature* (cit. n. 4); and Findlen, “Controlling the Experiment” (cit. n. 13). Redi spoke in *Esperienze* (cit. n. 13) of having the honor of serving in a court where men from all over the world came to pay their respects to the grand duke (p. 3); he boasted that the Accademia del Cimento flourished “under the protection of the Most Serene Prince Cardinal de Medici” (p. 31). Redi also described the botanical gardens kept by Cosimo III, “who numbers among his most cherished actions to earn by his protection, grace, and liberality the approval of the professors of the sciences and fine arts” (p. 58).

could acquire it only through the one official pharmacy in Florence. Redi certainly realized that acceptance of the snakestones as a legitimate remedy for poisoning would seriously jeopardize a traditional source of income and prestige for his Medici patrons. His concern to preserve the reputation of theriac as the only efficacious antivenom—and thereby to safeguard Medici financial interests—might well explain Redi's alacrity to subject snakestones to experimental trials.²⁸

Redi's position at the Medici court offered him a significant advantage over Kircher as an experimenter, for toxicological trials required both toxins and live animals. Because the Medici grand duke was passionately addicted to the hunt, Redi had superior access to animal specimens. In fact, the entire Tuscan court—and Redi, as a member of its retinue—spent months traveling from one hunting reserve to the next and expended a great deal of time capturing and slaughtering animals of many species. Animals not used in the Medici kitchen were routinely made available for Redi's experimental projects. Cosimo, like his father and grandfather, also invested considerable energy in collecting specimens of rare and exotic animals—including ostriches, bears, and elephants—and Redi's correspondence reveals him dissecting beasts as strange as Egyptian crocodiles and giant sea turtles. Boxes of vipers from Naples and scorpions from Tunisia were not merely fringe benefits for Redi; they directly enabled him to contrive and perform his toxicological experiments and to produce his "scientific facts." Repeatability was not only epistemologically desirable for Redi; it was also logistically possible given his social and professional position in the Medici court.

While Redi plied his trade as court physician in Tuscany, Kircher lived quite a different life as a scriptor in the Jesuit college at Rome. Freed from financial constraints by virtue of living as a celibate man in a well-endowed religious society, Kircher shared none of the physician's nagging worries about acquiring and maintaining a clientele. But although Kircher may have enjoyed greater financial security than Redi, he was equally desperate to attract the favorable notice and patronage of powerful European princes. Living in papal Rome, and lacking direct access to a prince's company, with the opportunities for private conversation the physician's role afforded, Kircher was at a serious disadvantage when it came to soliciting patronage for his scientific and medical works. Since neither Pope Alexander VII nor Innocent X was particularly interested in patronizing natural philosophy or medicine, Kircher was forced to look beyond the confines of the Holy City to the Roman Catholic monarchs and princes of Europe as potential patrons.

To heighten the drama, Kircher had for decades been attempting to find a place at the Medici patronage trough in Florence, and Redi had every reason to view him as a competitor. While Kircher almost never left Rome after his arrival there in 1634, he had persistently presented himself to the Medici as a client seeking patronage. For years he had sent copies of his various books to the Medici in the hope that his erudition would be recognized. He had even dedicated a part of his multivolume *Oedipus Aegyptiacus* (1652–1654) to the Medici grand dukes and to Leopoldo, the brother of Cosimo and promoter of the Accademia del Cimento. Later he corresponded with the Medici counselor Alessandro Segni and wrote a Medici-blessed, if not Medici-commissioned, natural history of Tuscany and a genealogy of the Medici. Nor were these efforts to woo the Medici altogether unavailing: Leopoldo twice visited Kircher at his museum at Rome.²⁹

²⁸ While it is unclear exactly how important theriac was in the economy of the ducal pharmacy, it is beyond question that it was expensive to manufacture, highly prestigious, and frequently prescribed.

²⁹ See John Fletcher, "Athanasius Kircher, a Man under Pressure," in *Athanasius Kircher*, ed. Fletcher (cit. n.

In addition to using his published books to impress the Medici, Kircher also employed them to advertise the significant contributions his fellow Jesuits were making both to the discovery of scientific truths and to the advancement of the kingdom of Christ. As a propagandist for the Society's educational and missionary programs, he adroitly used every opportunity to win the favor of those Catholic nobles upon whom the Jesuits were politically and financially dependent for carrying on their missions. Thus his work on China served not merely to report on the civilization and natural curiosities found there, but also to advertise the Jesuit missionary program.

As a publicist for his Society Kircher followed a well-established Jesuit tradition, but his involvement as a Jesuit in the area of medicine and medical experiment was markedly novel. Because the Society had from its inception foresworn the study of medicine as one of its activities, the Jesuits in the sixteenth century had not posed a professional threat to physicians in the same way that they had become serious competitors to the orders that ran the educational institutions of Europe or staffed the strenuous missionary efforts of the Counter Reformation. Yet by the 1660s, the decade of the snakestone controversy, the Jesuits were making significant inroads into the medical field. Since overseas Jesuit missionaries often had no European-trained physicians to serve them in case of illness, they had become increasingly interested in and adept at the practice of physic. With growing frequency, pharmacies became attached to many of the Jesuit colleges.³⁰ We know from Kircher's writings that there was a pharmacy in the Collegio Romano and that Jesuits supervised the preparation of medicines there. It was here that Kircher had turned for his viper specimens.

Kircher's activity as a Jesuit natural philosopher who dabbled in medicine must have seemed threatening to Redi. For although Kircher did not attempt to dissemble his lack of training as a *medicus*—he openly acknowledged that he was no practitioner of medicine—he nevertheless thought he had every right to speak with authority as a natural philosopher who sought to understand the mysterious ways in which disease operated in the natural world. Thus when plague hit Rome in 1656 Kircher set out to chronicle the course of the epidemic, invoking Helmontian ideas to explain its cause and treatment. The result had been a published volume, *Scrutinium physico-medicum contagiosae luis quae pestis dicitur* (1658). Kircher had also included lengthy discussions of disease in his *Mundus subterraneus* of 1665.³¹

While it remains outside the bounds of this essay to chronicle the incursion of the Jesuits into areas traditionally belonging to university-trained practitioners of medicine, it is fair to remark that Redi in all probability was reacting to this intrusion upon his profession. The decade before the snakestone controversy had seen the introduction of cinchona bark to cure a broad array of "fevers" in Europe, and the Jesuits were realizing handsome profits by acting as supervisors of its collection in the forests of South America and as brokers for sales to Europeans. So close was the association of the new medicine with Jesuit

4), pp. 1–15; Fletcher, "Athanasius Kircher and His Correspondence," *ibid.*, pp. 139–178; and Fletcher, "Kircher and Duke August" (cit. n. 6). For a good account of Kircher's patronage strategies see Findlen, *Possessing Nature* (cit. n. 4), pp. 385–386.

³⁰ On the rise of pharmacies in Jesuit colleges and on the Jesuit interest in botany see Steven J. Harris, "Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit Scientific Tradition," *Science in Context*, 1989, 3:89–108. See also John O'Malley, *The First Jesuits* (Cambridge, Mass.: Harvard Univ. Press, 1993), pp. 343–344.

³¹ Athanasius Kircher, *Scrutinium physico-medicum contagiosae luis quae pestis dicitur* (Rome, 1658); and Kircher, *Mundus subterraneus* (cit. n. 12).

missionaries and with Jesuit pharmacies that quinine, its active ingredient, was commonly known as “Jesuits bark” or “Jesuits powder.” Nor was the “Jesuits bark” the only instance where the Society seized opportunities to market new medicines; the Jesuits had introduced and were promulgating—and selling—many of the exotic new substances whose efficacy Redi refuted so vehemently in his published letter to Kircher. Redi was horrified, for example, that some Jesuits hawked hippopotamus teeth to stanch blood and to temper lustful appetites.³²

By midcentury Jesuits had begun to compete with court physicians and pharmacists in yet another way, seizing upon the established courtly practice of sending gifts of pharmaceuticals to esteemed nobles. While neither Redi nor Kircher was in a position to profit financially from sending chests of medicines to important people, each lived in a culture where the presentation of such gifts had a heavy significance for patronage relations. Giovanni Targioni-Tozzetti records instances of Redi’s supervising the shipment of elegantly decorated wooden boxes of medicines to scholars and monarchs in Paris and Prague. Kircher’s correspondence, likewise, shows him dispatching a wooden chest of medications to one of his patrons.³³

Rather than viewing Redi’s disdain for the new medicinal substances arriving in Europe from the New World and East Indies as a consequence of wisdom acquired from his experimentalism and empirical observations, I would suggest that much of his hostility to the new medicines stemmed from his reaction to the intrusion of new and suspicious players in the field of medicine. He held that patients should shun Jesuit medical advice, for no Jesuit had university training as a physician. A review of Redi’s written (and posthumously published) case histories of the patients he treated reveals him to be not a daring, if patient, experimentalist but a conservative and traditional Galenist. Like other university-trained physicians who were his contemporaries, Redi prescribed elaborate diets, complicated mineral waters, bloodlettings, purges, clisters, and complex syrups, pills, and broths concocted from mixtures of plant and animal substances. He was remarkably reluctant to accept quick-acting mineral-based drugs advocated by the Helmontians. Instead, he showed a noted preference for the most traditional remedies, such as donkey’s milk, viperated wine, coriander, oil of malva, rind of pomegranate, gelatin of hart’s horn, and cassia pulp.³⁴ He especially favored elaborate dietetic regimens of herb-laced broths and gentle doses of plant-based purges.

WHO CAN BE TRUSTED?

In addition to the glaring professional rivalry animating the dispute, the snakestone debate was fueled by the protagonists’ divergent notions of the constitution of objective facts of nature. It might seem that it should have been a straightforward matter to assess whether the stones possessed an innate natural power to cure poisoned animals. But Redi and Kircher privileged quite different forms of knowledge in answering the question. Kircher gave credit to reports of natural phenomena observed by European Jesuits living overseas (see Figure 4). In his book on China Kircher tended to report fully the tales of natural marvels and monstrosities sent to him by his fellow Jesuits. While he would impugn the

³² Redi, *Esperienze* (cit. n. 13), pp. 69–70.

³³ Targioni-Tozzetti, *Notizie* (cit. n. 3), Vol. 3, pp. 128–129; and Fletcher, “Kircher and Duke August” (cit. n. 6), pp. 127, 129, 131.

³⁴ On Redi’s treatment of his patients and his commitment to Galenism see Basile, *Invenzione del vero* (cit. n. 13), pp. 89–124.

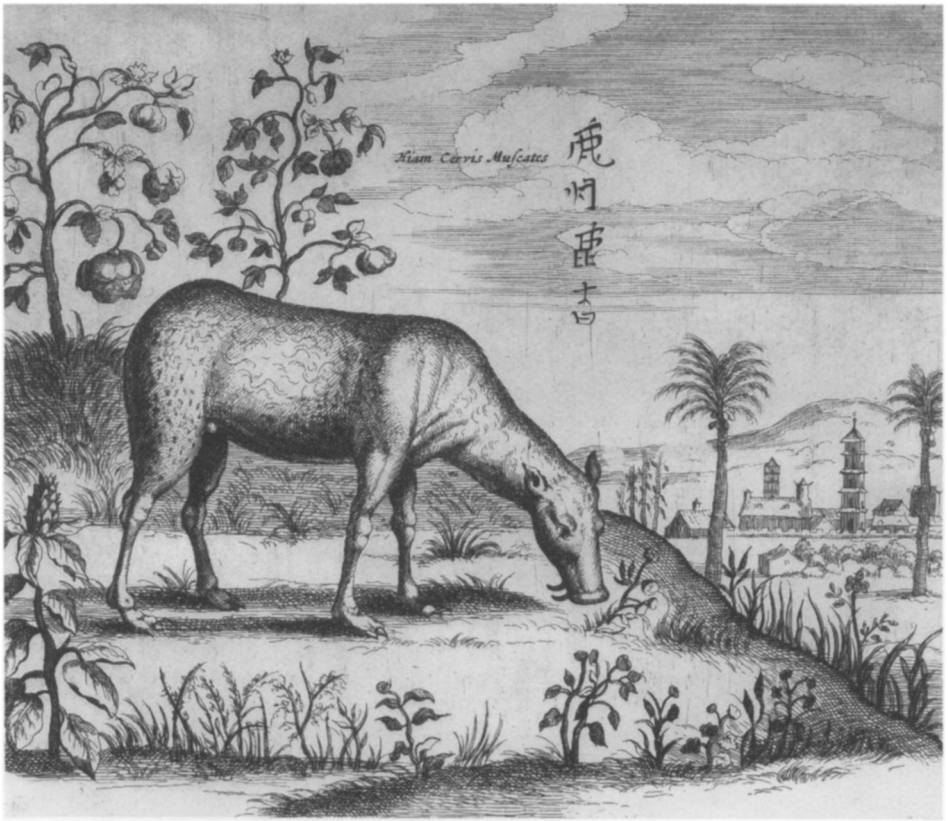


Figure 4. Athanasius Kircher, *China illustrata* (Amsterdam, 1667), p. 190. Kircher's plate of the Chinese musk indicates heavy borrowing from the missionary Jesuit Michal Boym. Compare with Figure 2, showing Boym's plate of 1656. (By permission of the Houghton Library, Harvard University.)

veracity of reports submitted by traveling merchants and secondhand accounts, he never publicly challenged the truth of an eyewitness report submitted by another member of the Society of Jesus. Kircher wrote that he felt compelled "not to repudiate them, on account of the assertions being made under religious oath."³⁵ Simply put, he believed that no Jesuit would willfully deceive him.

³⁵ Kircher, *Magneticum naturae* (cit. n. 8), pp. 51–52: "Visa haec primum fuerunt veluti paradoxa quaedam, quae minime tamen ob assertionem Patrum sub fide religiosa factam repudianda duxi."

Lorraine Daston and Peter Dear have suggested that the agreed-on parameters and methods for establishing facts derived from experiment and observation were undergoing a dramatic change at this time. Daston has pointed to the influence of Francis Bacon on the development of a new epistemology that privileged the accumulation of discrete, ascertainable facts in natural history. See Lorraine Daston, "The Factual Sensibility," *Isis*, 1988, 79:452–470; and Daston, "Baconian Facts, Academic Civility, and the Prehistory of Objectivity," *Annals of Scholarship*, 1991, 8:337–363. Peter Dear has pointed to a shift in the philosophical discourse of the early Royal Society away from facts used merely to illustrate generalized statements toward facts that legitimated historical reports of events. He has shown that such accounts ultimately had to convince the reader that the conclusion reported actually happened. See Peter Dear, "*Totius in verba*: Rhetoric and Authority in the Early Royal Society," *Isis*, 1985, 76:145–161; and Dear, "Miracles, Experiments, and the Ordinary Course of Nature," *ibid.*, 1990, 81:663–683. Shapin and Schaffer have further shown that in the very years of the snakestone controversy, English experimenters were granting the recording of particulars a greater place in the reports of their experimental results, whose interpretation could still remain highly controversial. See Shapin and Schaffer,

Sitting in Rome, the headquarters of the Society, Kircher was at the very center of an extremely efficient bureaucracy that ran a huge network of Jesuit correspondence. It was the Society's policy to require frequent and extensive reports from all its missionary posts and to gather information regarding the geography and natural history of every area where Jesuits labored in the vineyard of Christ; thus Kircher was deluged with reports of rare and marvelous natural phenomena observed by his brothers. It was this very kind of correspondence that he used to construct his scientific facts.

In contrast to Kircher, Redi mistrusted all field reports because he could not verify them. Moreover, he undoubtedly associated many such reports with missionaries. Although Redi—unlike many contemporary Galileans residing in Florence—was not openly contemptuous of the Jesuits, he was not particularly reverential toward them either. Redi was an observant Roman Catholic, but he was not about to accord the Jesuits or their observations any privileged epistemological standing. Indeed, he argued that India was full of swindlers and impostors who perpetrated all kinds of frauds on ignorant Europeans too naive to realize they were being taken. He deemed ridiculous, for example, the report of one Jesuit, Eusebius Nieremberg, who had claimed that in India when animals shed their horns, the horns put out roots like cabbages and became plants.³⁶ If snakestones were to be credited with healing power, they must be shown to work repeatedly before many reliable witnesses—indeed, before his very own eyes, in Florence. Redi made it clear that he cared nothing for field accounts.

Redi was not the first of his day to express a mistrust of field experience. No less important a philosopher than Descartes had shown open contempt for experiments and observations that others might send him. In the *Discourse on Method* Descartes suggested that a philosopher would do better to ignore such reports, since “for the most part [they were] composed of so many details and superfluities that it would be very hard to discern the truth in them; besides, one finds almost all of them to be so badly explained or even so false . . . that they cannot be worth the time one would have to spend in choosing them.”³⁷

But while Descartes prided himself on preserving the purity of his ideas and experiments by working in the relative seclusion of his Dutch farm, with only paid assistants, Redi spoke from a completely different cultural perspective. He privileged the authority of large gatherings of Florentine courtiers assembled to witness experiments performed before their very eyes. In Redi's view, experiments witnessed by unpaid, genteel, educated men were vastly superior to sporadic, occasional field experiences witnessed by a single observer. Unequivocal demonstrations were infinitely preferable to written reports of disparate missionaries living far apart from each other in foreign lands. So strong was Redi's scorn for field observations that Petrucci accused him of dismissing all the experiments that had taken place in Brazil, India, Vienna, Rome, Venice, Frascati, and Tivoli as “not totally truthful because they did not take place beneath your very eyes.” To Petrucci's mind, Redi asserted the worthlessness of the snakestones because he accepted only his own experimental results as certain.³⁸

Leviathan and the Air-Pump (cit. n. 19), pp. 55–65; and Steven Shapin, *A Social History of Truth* (Chicago: Univ. Chicago Press, 1994).

³⁶ Redi, *Esperienze* (cit. n. 13), pp. 113–114.

³⁷ René Descartes, *Discourse on Method and Meditations on First Philosophy*, trans. Donald Cress (Indianapolis: Hackett, 1980), *Discourse*, p. 39.

³⁸ Petrucci, *Prodromo apologetico alli studi Chircheriani* (cit. n. 20), p. 63. Descartes defended his decision to work alone and to use only paid craftsmen whose lower economic status obliged them to do precisely as he

Similar issues surfaced in other debates in early modern science and medicine. In their account of English experiments on the vacuum, Steven Shapin and Simon Schaffer have demonstrated that much depended on the willingness of absentee witnesses to testify to the truth of experiments about which they had received only verbal reports. In pressing their point, these authors have constructed the category of the “virtual witness” who testified for the truth of experimental results after becoming convinced through reading detailed, particular accounts. While Boyle, Hobbes, and Kircher may have accepted the notion of the virtual witness, Redi clearly did not. In private correspondence with a gentleman of Lucca who was conducting his own trials with snakestones, Redi stated succinctly what he had hoped to accomplish by publishing his lengthy letter to Kircher: “The principal point of this letter was for me the experiments which I conducted with this stone, which notwithstanding the witnessing (*attestazione*) of so many authors, has always, always proved itself to me in all the trials most useless and of no value.”³⁹ Redi made it clear that he was well aware that many besides Kircher had “witnessed” the snakestones’ marvelous powers as an antidote, but he gave virtually no credit to their testimony and felt free to dismiss their accounts. For Kircher, as for most other natural philosophers of his age, harshly discounting the faithfully pledged testimony of a social and intellectual peer breached the tacit code of proper behavior.

One can only speculate that Kircher’s willingness to accept evidence produced beyond his immediate supervision was deeply nurtured by the spiritual practices of the Society of Jesus. Kircher lived in a religious society that inculcated a strong sense of solidarity among its members. The founding documents of the Society of Jesus express the respect Jesuits were expected to accord one another. The constitutions, written by Ignatius of Loyola, specifically mandated that members, especially novices, “should try and desire to give the advantage to the others, esteeming them all in their hearts as better than themselves and showing exteriorly, in an unassuming and simple religious manner, the respect and reverence befitting each one’s state.”⁴⁰ Moreover, the founder had commanded each Jesuit to endeavor to recognize God’s image in his brethren. By demanding that each member show esteem for his religious brothers, Ignatius reinforced the principle of self-abnegation and assured the cohesion of the Society. Clearly, Kircher’s willingness to accept the testimonies and field reports—however bizarre—of fellow Jesuits as truthful statements about nature reflects his religious training.

Aware of Kircher’s preference for Jesuit witnesses, Redi had a tactical advantage, for he could reassure his rival that many Florentine Jesuits had been witnesses to his experiments. To make his point stronger, Redi published their names. Attending several sets of trials were Antonio Veira, “the very famous Portuguese preacher,” Adam Adamando, “celebrated professor of Mathematics,” Erasmo Scales, and Antonio Michele Vinci,

wished. He scorned the “assistance” of other gentlemen, whose social status made them feel entitled to offer constant theoretical explanations of his experimental procedures (*Discourse*, p. 39). This contrasts markedly with Redi’s eagerness to assemble gentlemen to witness and thereby credit his Florentine experiments. Redi’s correspondence suggests some willingness to credit the corroborative testimony of experiments performed by others known to him. In a series of letters to Francesco Fiorentini, a gentleman of Lucca, Redi wrote that he deeply regretted not being able to include Fiorentini’s snakestone experiments in his treatise, which had already gone to the printer. Redi may have been merely flattering his correspondent. See Francesco Redi to Francesco M. Fiorentini, 24 Oct. 1671, in *Lettere di Francesco Redi*, ed. C. D. Moreni (Florence: Stamperia Magheri, 1825), p. 16.

³⁹ Redi to Fiorentini, 16 July 1671, *ibid.*, p. 12.

⁴⁰ Ignatius of Loyola, *The Constitutions of the Society of Jesus*, trans. and ed. George Ganss (St. Louis: Institute of Jesuit Sources, 1970), sect. 250, p. 155.

“reader of theology and philosophy in your Florentine College.” Furthermore, Father Mar-raci, “father of your most venerable Society and a very wise man and sagacious and experienced about things of the Indies,” had witnessed his second set of trials, where the results were uncontested.⁴¹

EXPERIMENTAL EVIDENCE AND LABORATORY EXPERIMENTS IN EARLY MODERN MEDICINE

If Kircher and Redi could never agree about the efficacy of the snakestone to cure poisoning, they did agree in according experimental trials on animals a legitimate place in medical knowledge. Robert Frank and Anita Guerrini have documented the growing role of experiments on live animals in seventeenth-century Europe. Others, including Harcourt Brown and Audrey Davis, have studied a group of English and French animal experiments pertaining to blood transfusion that were almost exactly contemporary with those on the snakestone. It is in this context of a rising interest in medically related experimentation that the snakestone experiments transpired.⁴²

Scrutiny of the debate reveals that both experimenters and observers harbored high hopes that the trials on snakestones would be definitive. Externally applied medicaments like the snakestone presented a significant opportunity for experimental testing. Presumably the effects would be easily observable and the outcome of the trials readily discernible and uncontroversial. Moreover, since neither Kircher nor Redi was willing to subject humans to contrived trials, animal subjects offered the experimenters a convenient opportunity to test a remedy destined ultimately for human application.

In addition to sharing a basic commitment to the validity of experimental animal trials in medicine, both Kircher and Redi were concerned to observe the bounds of morally and socially acceptable behavior. These two protagonists were by no means the first seventeenth-century antagonists to dispute openly the proper interpretation of experimental evidence. But by midcentury the high hopes that experimentalists pinned on their trials led them to become increasingly circumspect in the pursuit of their debates. The English natural philosopher Robert Boyle, whom both Redi and Kircher admired, had written about the injurious consequences for the state of knowledge if philosophers should fail to accord belief and respect to disputants. In a work of 1661, “Two Essays, Concerning the Unsuccessfulness of Experiments,” Boyle elaborated numerous possible explanations that might account for conflicting results of laboratory trials. He claimed that his motive in discussing how experiments might go awry was concern that experimenters might not publish their results if they feared “blasting imputations of falsehood” and “exposing their reputation” to the insults of those whose results were discordant with their own. Indeed, as Boyle’s essay suggests, scientific disputes were becoming more and more bound up within a code of etiquette. The acrimony and name-calling that had enlivened the debates among the early Paracelsians, astrological physicians, and Galenists were dying out. While Boyle exempted outright frauds from his charitable judgment, he was inclined to extend belief

⁴¹ Redi, *Esperienze* (cit. n. 13), pp. 10, 11.

⁴² See Robert Frank, *Harvey and the Oxford Physiologists: A Study of Scientific Ideas and Social Interaction* (Berkeley: Univ. California Press, 1980), esp. pp. 141–178; Anita Guerrini, “The Ethics of Animal Experimentation in Seventeenth-Century England,” *J. Hist. Ideas*, 1989, 50:391–407; Harcourt Brown, “Jean Denis and Transfusion of Blood: Paris, 1667–1668,” *Isis*, 1948, 39:15–28; and Audrey B. Davis, *Circulation Physiology and Medical Chemistry in England, 1650–1680* (Lawrence, Kans.: Coronado, 1973). For a broader review of the increased English interest in experiments in these years see Hall, *Promoting Experimental Learning* (cit. n. 1).

to any experimenter who was seeking to reveal the truths of nature: "I think it but a piece of equity, becoming both a Christian and a philosopher, to think . . . that he set down his experiment or observation as he made it, though for some latent reason it does not constantly hold, and that therefore though his experiment be not to be relied upon, yet his sincerity is not to be rejected."⁴³ Lest the communication of experimental results among learned men be retarded, Boyle commended credulity over skepticism.

On the surface, the snakestone disputants behaved in accordance with Boyle's model. Redi was almost obsequious in his public deference to Kircher, and Kircher never publicly returned the challenge of his opponent. While each remained adamant in his judgment about the snakestone, neither ever questioned the experimental results of his opponent. Redi made it clear that he did not doubt that Kircher's viper-bitten dog had in fact recovered after the application of the snakestone: "I believe it, I hold it for very true, and I give it as much faith as is appropriate for any evident truth." He merely questioned whether one could properly attribute the dog's recovery to the stone rather than to the animal's strong natural and temperamental resistance to poisoning. Redi had conducted literally hundreds of experiments with live vipers in his earlier work, and he was well aware that experimental trials could produce results contrary to expectations. Thus he offered several plausible explanations to account for the survival of the one cock in his earliest set of trials: perhaps the oil of tobacco had not reached the bloodstream; perhaps the particular batch of toxin had been weak, owing to vagaries of the soil and climate where the tobacco had been grown; perhaps the cock had recently ingested a large amount of food and had thereby increased his resistance to the poison.⁴⁴

Redi politely hinted that Kircher was not the only contemporary natural philosopher to have his experimental investigations go sour. He pointedly cited the many experimental "failures" that Boyle had endured, giving a full account of his tortured attempts to replicate Francis Bacon's experimental claim that brandy always floats above oil of almonds. He commended Boyle's essay "Concerning the Unsuccessfulness of Experiments" to Kircher's reading, for here the great English experimenter had addressed many issues bearing directly on experimental replicability and theoretical misinterpretation of experimental evidence.⁴⁵ Redi also noted that experimental failures did not vex only the distant English. He forthrightly admitted that he himself had patiently but unsuccessfully attempted many times to replicate an experiment from the early years of the Accademia del Cimento, reported in its *Saggi* as having been performed in front of many witnesses. In discussing why his own experiments contradicted the earlier evidence obtained by the academicians, Redi suggested several possible variants in experimental conditions or laboratory equipment, but he never cast doubt on the results of his predecessors.⁴⁶

⁴³ Robert Boyle, "Two Essays, Concerning the Unsuccessfulness of Experiments, Containing Divers Admonitions and Observations (Chiefly Chemical) Touching that Subject," in Boyle, *Works*, ed. Thomas Birch, 5 vols. (London, 1744), Vol. 1, pp. 204–227, on p. 224. See also Shapin, *Social History of Truth* (cit. n. 35).

⁴⁴ Redi, *Esperienze* (cit. n. 13), pp. 13 (quotation), 40.

⁴⁵ The essay of Robert Boyle about which Redi speaks here, "Two Essays, Concerning the Unsuccessfulness of Experiments" (cit. n. 43), was originally published as part of his *Certain Physiological Essays* (London, 1661). The essay was translated into Latin in 1669; it was this edition that Redi consulted and recommended to Kircher. I have consulted it in Boyle, *Works*, ed. Birch (cit. n. 43). Redi held Boyle in high esteem; in *Esperienze* (cit. n. 13) he spoke of "Ruberto Boile, Gentiluomo inglese, Litterato di alta fama, dotto, diligente, e sempre veridico, e meritevole d'ogni lode più sublime" (p. 30). On the influence of Boyle in seventeenth-century Italy see Clelia Pighetti, *L'influsso scientifico di Robert Boyle nel tardo '600 italiano* (Milan: Franco Angeli, 1988).

⁴⁶ The experiment involved the infusion of water in a lead bell. The *Saggi* reported that all waters of rivers, fountains, and wells turned muddy after coming into contact with the bell—with the exception of waters from the pipes of Pisa, which retained their native limpidity. When Redi repeated the experiment he found that even the water of Pisa "turns white and gets muddy to the greatest surprise of all those who had experienced to the

Similarly, Petrucci was willing to include in *Prodromo apologetico alli studi Chircheriani* experimental evidence contrary to his theoretical expectations and to acknowledge that not every trial with the snakestone had been successful. He related that when two Jesuits attempted to cure Father Otto Cronsfeld of an unspecified mortal disease the snakestone had not worked. Petrucci ascribed this outcome to the Jesuits' inappropriate application of the stone to a nonpoisonous disease, but he did not quibble about its failure. Following Redi's example of explaining away the contrary evidence of an opponent, Petrucci was quite willing to devise an alternative explanation for Redi's results. Redi had ascribed the survival of the third cock to its robust and resistant nature; Petrucci tauntingly invoked the "weak, flabby, and feeble nature" of the first two cocks.⁴⁷

Whereas Redi had turned to Robert Boyle for help in explaining baffling experimental trials, Petrucci invoked yet another god of the scientific method. In choosing Galileo as his icon, Petrucci was deliberately calling upon the hero of the Florentine experimenters as he reproached Redi for scientific narrow-mindedness and pigheaded loyalty to medical orthodoxy. Petrucci quoted long passages from *The Assayer*, in which the master had argued that "many things are told otherwise than are done; for the most part what is reported as having been tried or experienced, what is adduced in books as proved, are the fictions of passionate intellects. The very small accuracies described in the experimental reports are but shrewd fine points of those who attempt to fool themselves."⁴⁸

Redi undertook his experiments not merely to disprove the efficacy of the snakestones but, more importantly, to argue for leaving newfangled medicinal substances alone. As a convinced Galenist, Redi believed that disease resulted from an upset in the delicate balance of a patient's individual humoral complexion. He was thus quite negative about the value of experimental trials undertaken to assess the therapeutic efficacy of medicines on humans: "I know that the most fallacious experiments are those performed on medications, because the same disease can happen in different bodies for different reasons."⁴⁹ Moreover, Redi believed that wildly varying ambient circumstances in the preparation of pharmaceuticals made it difficult if not impossible to assess any medicine—traditional or exotic—with accuracy. Rather than seeing Redi as an unqualified advocate of the new experimental science, I find him confining his experiments to the physiological knowledge of lower animal forms and remaining deeply suspicious of any changes in medical therapeutics.

CONCLUSION

That these natural philosophers did not come to a consensus about the snakestone therapy suggests some of the essential complexity of even the relatively simple experimental activity of the early modern period. Despite the availability of experimental spaces in the pharmacies of both the grand duke and the Jesuit college, despite there being no require-

contrary hundreds and hundreds of times": Redi, *Esperienze* (cit. n. 13), pp. 31–39, quotations from p. 31. Among the factors that Redi considered as potentially accountable for the discrepancies in experimental outcomes were variations in the metallic compositions of the bells and in the heat applied in the casting process.

⁴⁷ Petrucci, *Prodromo apologetico alli studi Chircheriani* (cit. n. 20), pp. 21, 26.

⁴⁸ *Ibid.*, p. 27. On the close bonds between Galilean science and the Accademia del Cimento see Galuzzi, "Accademia del Cimento" (cit. n. 5); Baldini, "Scuola galileiana" (cit. n. 17); and Michael Segre, *In the Wake of Galileo* (New Brunswick, N.J.: Rutgers Univ. Press, 1991), esp. pp. 127–142. While Segre's work challenges the prevailing orthodoxy of more traditional historiography that the Accademia del Cimento took up the Galilean program *in toto*, it nevertheless supports a strong connection between the two.

⁴⁹ Redi, *Esperienze* (cit. n. 13), p. 66.

ments for instrumentation or technical apparatus, despite access to live animal specimens, toxins, and imported snakestones, despite the ease with which competent witnesses could be assembled, and despite the apparent simplicity in the design of the experiments, the efficacy of the snakestone remained a matter of dispute. Experimenters rated field reports and laboratory trials differently; their epistemological assumptions clearly influenced the design and interpretation of the experimental trials; their assumptions of how diseases operated inside the body differed markedly; professional and religious loyalties predisposed them to interpret the experimental outcomes in opposing ways. Although modern historians may be tempted to side with Redi's characterization of his adversaries' claim as "an ingenious invention purely from the mouths of men avid for novelties," a closer examination of the debate reveals that knowledge of the natural world derived from experiment was neither clear nor uncontested in the seventeenth century. Redi's stature as an experimentalist and as a physician notwithstanding, he was unable to convince the wider community of European natural philosophers and physicians that the snakestone remedy was of no value.⁵⁰

While it is beyond dispute that interest in the snakestone experiments withered, the stones themselves did not disappear from European medicine. Robert Boyle was well aware of Redi's experiments but nonetheless endorsed the efficacy of the snakestones. Although Boyle claimed that he had performed his own experiments with the stones and that they had failed, he considered more authoritative the *testimony* of a great traveler in southern India, who told the English experimenter that he had cured more than sixty persons of various types of poisoning with the snakestones.⁵¹ As late as 1687 the *Philosophical Transactions* reported that the eminently respectable English physician Edward Tyson used the stones in his own medical practice. Similarly, Giorgio Baglivi, a respected Italian physician, knew of Redi's experiments but chose not to accept the Tuscan's conclusions after receiving correspondence from a Jesuit in Calabria who had witnessed one miraculous cure with a snakestone on a local peasant. This led Baglivi to endorse the use of the stone as late as the 1730s. Nicolas Leméry included the snakestone in his famous compendium of drugs in the early eighteenth century.⁵²

Like the contemporaneous debate over spontaneous generation, the snakestone debate was not swiftly concluded. While experimenters could perform laboratory trials in hours

⁵⁰ *Ibid.*, p. 115: "un ingegnosa invenzione della sola gola de' Moderni avida sempre delle novità, che tanto più sono in pregio, quanto di più lontano ei sono portate."

⁵¹ In 1687 Redi found himself solicited by an unknown, impecunious Portuguese gentleman writing from Rome. Martino Mesquita described the purported medicinal properties of his snakestone, which he hoped the grand duke would want for his collection. Redi's polite acknowledgment disabused Mesquita of his hopes; however, he did not reopen the Pandora's box of experiment or suggest that Mesquita undertake his own trials on the snakestone. By 1687 Kircher was dead, and Redi seemed content to let the snakestone experiments die as well. See Francesco Redi, *Opere di Francesco Redi*, 9 vols. (Milan, 1811), Vol. 8, pp. 177–180. For Boyle's view see Robert Boyle, "The Advantages of the Use of Simple Medicines," in Boyle, *Works*, ed. Birch (cit. n. 43), Vol. 4, pp. 325–338, on pp. 337–338. Willing to dismiss Redi's experiments as having been performed with fraudulent stones, Boyle also cited the testimony of "one of the eminentest doctors of the London college," "one of our chief English Chirurgeons," and "a very intelligent person, who had the direction of a considerable company of traders in East India" (*ibid.*).

⁵² In a report printed in *Philosophical Transactions*, 1687, 144:25–54, Edward Tyson included a description of the snakestone as part of his larger account of the American rattlesnake (pp. 49–51). Tyson claimed he had found the snakestone efficacious in treating a female patient suffering from gout. On Tyson and his place in the medical world of London in the late seventeenth century see Cook, *Decline of the Old Medical Regime* (cit. n. 24), pp. 194–195. For Baglivi's endorsement of the efficacy of the snakestone see Giorgio Baglivi, "Dissertatio de tarantula," in *Opera omnia* (Bassani, 1738), pp. 447–471, on p. 464. Baglivi stated that at first he had been persuaded by Redi's experiments but had changed his mind after receiving correspondence from a Jesuit, Johannes Dominicus Putignanus. Baglivi cited and translated the entire letter of his Jesuit witness. For Leméry on the snakestone see Nicolas Leméry, *Le traité universel des drogues simples* (Paris, 1702), pp. 463–464.

or days, field reports accumulated over a period of years, even decades. By the time the widely respected naturalist Paolo Boccone wrote about the snakestones in 1697, almost two decades after Kircher's death, he could further expand the evidence in favor of the snakestone: Giuseppe Maffei, a Jesuit from Lucca, had made four more experiments in Rome; members of the court of Cardinal Chigi had cured several viper-bitten hunting dogs; others had testified that the stones cured painful spider bites; in Germany the stone had cured a patient bitten by a rabid wolf; further correspondents reported the snakestones' success when applied to the wrists of patients suffering "malignant fevers." Finally, Boccone could confirm with his own self-experiment the report of many cures of "windy belly" effected by applying snakestones to the rectums of suffering patients.⁵³ This slow accretion of evidence gathered from correspondence and verbal reports explains to a large degree why the snakestone had a far longer life as a medical ingredient than as an experimental subject. The evidence of experiment proved itself a remarkably fragile commodity in early modern Europe, while the field report, the standard fare of natural history, continued to enjoy notable health throughout the seventeenth century.

⁵³ Paolo Boccone, *Museo di fisica e de esperienze: variato, e decorato di osservazioni naturali, note medicinali, e ragionamenti secondi i principii de' moderni* (Venetia, 1697), pp. 104–109. On the longevity of the controversy over spontaneous generation see John Farley, *The Spontaneous Generation Controversy from Descartes to Oparin* (Baltimore: Johns Hopkins Univ. Press, 1974). On the closure of scientific debates in general there is a long—and growing—literature. See especially Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Milton Keynes: Open Univ. Press, 1987); Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton, N.J.: Princeton Univ. Press, 1986); Peter Galison, *How Experiments End* (Chicago: Univ. Chicago Press, 1987); David Gooding, Trevor Pinch, and Simon Schaffer, eds., *The Uses of Experiment: Studies in the Natural Sciences* (Cambridge: Cambridge Univ. Press, 1989); and H. Tristram Engelhardt, Jr., and Arthur Caplan, eds., *Scientific Controversies* (Cambridge: Cambridge Univ. Press, 1987).